TITLE OF THE INVENTION

EXPOSURE APPARATUS, SEMICONDUCTOR DEVICE MANUFACTURING
METHOD, EXPOSURE APPARATUS MAINTENANCE METHOD AND
SEMICONDUCTOR MANUFACTURING FACTORY

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FIELD OF THE INVENTION

The present invention relates to an exposure
apparatus capable of selectively switching between
exposure method according to exposure conditions and a
10 method of manufacturing semiconductor devices using the
exposure apparatus.

BACKGROUND OF THE INVENTION

It is generally known that a conventional scanning
15 type exposure apparatus performs exposure after the
speeds of a matrix, substrate and light-shielding plate
are stabilized.

On the other hand, the Japanese Patent Laid-Open
No. 9-223662 specification discloses a scanning type
20 exposure apparatus that performs exposure even when any
stage(s) is (are) accelerating or decelerating. On the
other hand, there was also a step and repeat type
exposure apparatus before scanning exposure (static
exposure method).

25 In the past, different exposure method would be
constituted by different exposure apparatuses and used
for different purposes. Each exposure method had its

own features, and the user would determine the exposure method according to the content to be processed by the exposure apparatus and selectively use the appropriate exposure apparatus. However, in the conventional

5   exposure apparatuses, different exposure methods would be constituted by different machines, those machines would be reused among different processes and the user would determine the exposure method according to the contents to be processed by the exposure apparatus,

10   which would make it difficult to optimize throughput.

On the other hand, the Japanese Patent Laid-Open No. 8-55794 specification discloses a technique that a comparison is made between the size of an effective exposure area of an optical system and the size of an

15   exposure angle of view, if the exposure angle of view is smaller, a step and repeat system is selected and if the exposure angle of view is larger, it is only possible to perform exposure according to a step and scan system and therefore exposure is performed

20   according to the step and scan system.

However, this technique had a problem that it would not be possible to take full advantage of features of the respective exposure methods because it only compared whether it would be possible to print or

25   not based on a comparison between the effective exposure area and exposure angle of view. For example, the step and scan system (hereinafter referred to as

"scanning exposure method") would ignore the advantage of the scanning exposure method of being able to adjust the projection magnification ratio for the scanning direction and non-scanning direction separately.

5   It is an object of the present invention to provide an exposure apparatus capable of selectively switching between exposure methods, improve the operation of the exposure apparatus through such switching between exposure methods and provide an

10   exposure apparatus capable of optimizing throughput of the exposure apparatus and a method of manufacturing semiconductor devices, etc. using the exposure apparatus.

15   SUMMARY OF THE INVENTION

The present invention has been proposed to solve the conventional problems, and has as its object to provide an exposure apparatus capable of executing a plurality of exposure methods and featuring switching

20   means for switching between the plurality of exposure methods. The switching means may also be characterized by the capability of switching between a plurality of exposure methods such as scanning exposure at a constant speed, scanning exposure at a variable speed

25   and static exposure according to different purposes such as increasing productivity, focusing on accuracy or doing maintenance.

The exposure apparatus capable of selectively switching between a plurality of exposure methods according to the preset invention comprises:

setting means for setting exposure conditions for
5 an exposure target;

calculating means for calculating evaluation item values to determine an exposure method based on the set exposure conditions; and

determining means for selecting an exposure method
10 that matches the exposure conditions for the exposure target based on the evaluation item values calculated by the calculating means.

The determining means in the above-described exposure apparatus preferably selects from among the
15 plurality of exposure methods taking into account at least two evaluation item values for every wafer, shot or lot.

The calculating means in the above-described exposure apparatus preferably calculates the evaluation
20 item values based on an evaluation item value calculation expression:

$$C(N): = F(SYL(N)) + G(SX(N), SY(N)) + H(\delta X(N), \delta Y(N)) + K(L) + P(M) + Q(S, SY(N))$$

and the exposure conditions set by the above-
25 described setting means.

The calculating means in the above-described exposure apparatus preferably calculates the evaluation

item values according to the location of a shot based on the position of the shot in the non-scanning direction (SX) on a substrate and/or the position of the shot in the scanning direction (SY) on the substrate and data.

The calculating means in the above-described exposure apparatus, in the calculation of the evaluation item values, preferably calculates evaluation item values related to a shape shift of a shot base pattern during multiple printing based on an image shift (δX) in the non-scanning direction in the shot and/or image shift (δY) in the scanning direction in the shot.

The calculating means in the above-described exposure apparatus, in the calculation of the evaluation item values, preferably evaluates whether or not to use previously measured correction data based on a shot layout correlation coefficient (L).

The calculating means in the above-described exposure apparatus, in the calculation of the evaluation item values, preferably calculates evaluation item values taking into account at least any one of the shot, substrate and lot printing method indication value (M).

The calculating means in the above-described exposure apparatus, in the calculation of the evaluation item values, preferably calculates

evaluation item values to synchronize the drive stages taking into account a synchronization accuracy target value (S).

The plurality of exposure methods in the above-described exposure apparatus preferably include three exposure methods of static exposure that performs exposure with the stage standing still, constant speed scanning exposure with the stage running at a constant speed while carrying out scanning exposure and accelerated/decelerated scanning exposure with the stage running at an inconstant speed while carrying out scanning exposure, and

the determining means selects an exposure method that matches the exposure conditions from among the three exposure methods based on the evaluation item values.

Furthermore, the exposure apparatus capable of selectively switching between a plurality of exposure methods according to the present invention includes:

setting means for setting exposure conditions for an exposure target;

calculating means for calculating evaluation item values to determine an exposure method based on the set exposure conditions; and

determining means for selecting an exposure method that matches the exposure conditions for the exposure

- 6 -

target based on the evaluation item values calculated by the calculating means,

in which the calculating means, in the calculation of the evaluation item values, calculates evaluation item values according to the location of a shot based on the position of the shot in the non-scanning direction on a substrate and/or the position of the shot in the scanning direction on the substrate and data, and

the determining means selects an exposure method that matches the location of the shot according to the calculated evaluation item values.

Furthermore, the exposure apparatus capable of selectively switching between a plurality of exposure methods according to the present invention includes:

setting means for setting exposure conditions for an exposure target;

calculating means for calculating evaluation item values to determine an exposure method based on the set exposure conditions; and

determining means for selecting an exposure method that matches the exposure conditions for the exposure target based on the evaluation item values calculated by the calculating means,

wherein the calculating means, in the calculation of the evaluation item values, calculates evaluation item values related to a shape shift of a shot base

pattern during multiple printing based on an image shift in the non-scanning direction in the shot and/or image shift in the scanning direction in the shot,

the determining means selects an exposure method that matches conditions of the shape shift of a shot base pattern according to the calculated evaluation item values during the multiple printing.

Furthermore, the exposure apparatus capable of selectively switching between a plurality of exposure methods according to the present invention includes:

setting means for setting exposure conditions for an exposure target;

calculating means for calculating evaluation item values to determine an exposure method based on the set exposure conditions; and

determining means for selecting an exposure method that matches the exposure conditions for the exposure target based on the evaluation item values calculated by the calculating means,

wherein the calculating means, in the calculation of the evaluation item values, evaluates whether or not to use previously measured correction data based on a shot layout correlation coefficient, and

the determining means selects an exposure method according to the evaluation as to whether or not to use the evaluated previously measured correction data.

- 8 -

Furthermore, the exposure apparatus capable of selectively switching between a plurality of exposure methods according to the present invention includes:

setting means for setting exposure conditions for

5   an exposure target;

calculating means for calculating evaluation item values to determine an exposure method based on the set exposure conditions; and

determining means for selecting an exposure method

10   that matches the exposure conditions for the exposure target based on the evaluation item values calculated by the calculating means,

in which the calculating means, in the calculation of the evaluation item values, calculates evaluation

15   item values taking into account at least any one of the shot, substrate and lot printing method indication values, and

the determining means selects an exposure method that matches the specified printing method based on the

20   calculated evaluation item values.

Furthermore, the exposure apparatus capable of selectively switching between a plurality of exposure methods according to the present invention includes:

setting means for setting exposure conditions for

25   an exposure target;

calculating means for calculating evaluation item values to determine an exposure method based on the set exposure conditions; and

determining means for selecting an exposure method

5   that matches the exposure conditions for the exposure target based on the evaluation item values calculated by the calculating means,

in which the calculating means, in the calculation of the evaluation item values, calculates evaluation

10   item values to synchronize the drive stages taking into account a synchronization accuracy target value, and

the determining means selects an exposure method that matches the synchronization of the drive stage based on the calculated evaluation item values.

15   Furthermore, the exposure apparatus capable of selectively switching between a plurality of exposure methods according to the present invention includes:

setting means for setting exposure conditions for an exposure target;

20   calculating means for calculating evaluation item values to determine an exposure method based on the set exposure conditions; and

determining means for selecting an exposure method that matches the exposure conditions for the exposure

25   target based on the evaluation item values calculated by the calculating means,

- 10 -

in which the determining means selects based on the calculated evaluation item values one appropriate exposure method from among three exposure methods of static exposure that performs exposure with the stage standing still, constant speed scanning exposure with the stage running at a constant speed while carrying out scanning exposure and accelerated/decelerated scanning exposure with the stage running at an inconstant speed while carrying out scanning exposure.

The determining means of the above-described exposure apparatus preferably selects from among at least two exposure methods of constant speed scanning exposure with the stage running at a constant speed while carrying out scanning exposure and accelerated/decelerated scanning exposure with the stage running at an inconstant speed while carrying out scanning exposure.

The determining means of the above-described exposure apparatus preferably further selects static exposure that performs exposure with the stage standing still.

The calculating means of the above-described exposure apparatus preferably calculates the evaluation item values based on the exposure conditions for every lot, substrate and shot and the determining means switches between exposure methods according to the evaluation item values.

The semiconductor device manufacturing method
according to the present invention includes the steps
of:

    installing a plurality of semiconductor
5   manufacturing apparatuses for a plurality of processes
including an exposure apparatus in a factory; and

    manufacturing semiconductor devices through a
plurality of processes using the plurality of
semiconductor manufacturing apparatuses,

10   in which the exposure apparatus comprises:

    setting means for setting exposure conditions for
an exposure target;

    calculating means for calculating evaluation item
values to determine an exposure method based on the set

15   exposure conditions; and

    determining means for selecting an exposure method
that matches the exposure conditions for the exposure
target based on the evaluation item values calculated
by the calculating means.

20   The above-described semiconductor device
manufacturing method preferably includes the steps of:

    connecting the plurality of semiconductor
manufacturing apparatuses via a local area network;

    connecting the local area network and an external

25   network outside the factory;

acquiring information on the exposure apparatus
from a database on the external network using the local
area network and the external network; and

controlling the exposure apparatus based on the

5 acquired information.

The semiconductor manufacturing factory according
to the present invention includes:

a plurality of semiconductor manufacturing
apparatuses including an exposure apparatus;

10 a local area network that connects the plurality
of semiconductor manufacturing apparatuses; and

a gateway that connects the local area network and
an external network outside the semiconductor
manufacturing factory,

15 in which the exposure apparatus includes:

setting means for setting exposure conditions for
an exposure target;

calculating means for calculating evaluation item
values to determine an exposure method based on the set

20 exposure conditions; and

determining means for selecting an exposure method
that matches the exposure conditions for the exposure
target based on the evaluation item values calculated
by the calculating means.

25 Furthermore, the maintenance method for an
exposure apparatus according to the present invention
includes the steps of:

preparing a database for storing information on the maintenance of the exposure apparatus on an external network outside the factory in which the exposure apparatus is installed;

5 connecting the exposure apparatus to the local area network in the factory; and

performing maintenance of the exposure apparatus based on information stored in the database using the external network and the local area network,

10 in which the exposure apparatus includes:

setting means for setting exposure conditions for an exposure target;

calculating means for calculating evaluation item values to determine an exposure method based on the set

15 exposure conditions; and

determining means for selecting an exposure method that matches the exposure conditions for the exposure target based on the evaluation item values calculated by the calculating means.

20 The above-described maintenance method for an exposure apparatus preferably includes the steps of:

the vendor or user of the exposure apparatus providing a maintenance database connected to an external network outside the factory;

25 allowing access to the maintenance database from the semiconductor manufacturing factory via the external network; and

sending the maintenance information stored in the maintenance database to the semiconductor manufacturing factory via the external network.

The above-described exposure apparatus preferably

5 further includes:

an interface for connecting a network;

a computer for executing network software that performs data communication of the maintenance information of the exposure apparatus via the network;

10 and

a display for displaying the maintenance information of the exposure apparatus communicated by the network software executed by the computer.

The network software of the above-described

15 exposure apparatus preferably provides on the display a user interface for accessing maintenance database provided by the vendor or user of the exposure apparatus connected to an external network of the factory in which the exposure apparatus is installed

20 and allows information to be acquired from the database via the external network.

When a manual mode exposure method is specified as the exposure conditions, the determining means of the above-described exposure apparatus preferably selects

25 the specified exposure method independently of the evaluation item values, and

when an auto mode exposure method is specified as the exposure conditions, the above-described determining means selects an exposure method that matches the exposure conditions according to the

5 evaluation item values.

When it is impossible to realize the exposure method due to the exposure conditions, the determining means of the above-described exposure apparatus preferably registers a value exceeding threshold data

10 for selecting the exposure method as an offset value in the calculated evaluation item values or registers a value for reducing this threshold value as an offset value and determines a feasible exposure method.

Further objects, features and advantages of the

15 present invention, will become apparent from the following detailed description of embodiments of the present invention with reference to the accompanying drawings.

20 BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles

25 of the invention.

FIG. 1 is a schematic view showing a configuration of an exposure apparatus according to an embodiment of the present invention;

FIG. 2 is a perspective view showing exposure light intensity profile according to a scanning exposure method of the exposure apparatus according to the embodiment of the present invention;

FIG. 3 is a view illustrating a method of determining evaluation item values to determine an exposure method in the exposure apparatus according to the embodiment of the present invention;

FIG. 4 is a top view illustrating merits and demerits of a focus system with respect to a difference in the exposure method of the exposure apparatus according to the embodiment of the present invention;

FIG. 5A and 5B are views illustrating a method of processing an exception that occurs in determining an exposure method of the exposure apparatus according to the embodiment of the present invention;

FIG. 6 is a flow chart illustrating processing of the exposure apparatus to which the system according to the present invention is applied;

FIG. 7 is a flow chart illustrating processing in determining an exposure method of the exposure apparatus according to the embodiment of the present invention;

FIG. 8A and 8B are flow charts illustrating pre-processing in determining an exposure method of the exposure apparatus according to the embodiment of the present invention;

5   FIG. 9 is a conceptual diagram of a production system of semiconductor devices using the exposure apparatus according to the present invention viewed from a certain angle;

FIG. 10 is a conceptual diagram of the production
10   system of semiconductor devices using the exposure apparatus according to the present invention viewed from another angle;

FIG. 11 illustrates a specific example of a user interface;

15   FIG. 12 is a view illustrating a flow of a device manufacturing process; and

FIG. 13 is a view illustrating a wafer process.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS
20   Preferred embodiments of the present invention will now be described in detail in accordance with the accompanying drawings.

An embodiment of the present invention provides a hybrid exposure apparatus that selects from among a
25   plurality of exposure methods a system that matches exposure conditions and applies the system. Once each exposure method is selected, this hybrid exposure

apparatus can select shot information, parameters and a correction sequence required for the exposure method as appropriate and perform exposure.

The exposure apparatus that selectively switches between exposure methods can be implemented in the following apparatus configuration. A scanning type exposure apparatus comprises a control section that executes a plurality of stage driving methods and an exposure method determining section that calculates evaluation item values based on exposure conditions, determines an exposure method based on the determination result and determines parameters, a sequence and correction system necessary for the exposure method.

Processing contents of the exposure method determining section and the control section will be explained. There are two methods of switching between exposure methods; one method that the user explicitly switches between exposure methods taking into account the processing purpose and the other method that the exposure apparatus automatically determines an exposure method.

As the case where the exposure apparatus automatically determines an exposure method, it is possible to conceive a case where the angles of view of shots formed on a substrate, array mode, execution content and required accuracy are input to the exposure

- 19 -

apparatus. It is also possible to conceive a system whereby the required accuracy is directly determined from a recipe which is given on line. For example, it is possible to switch between a scanning exposure

5 method and static exposure method.

When an exposure with a small angle of view is performed, a step and repeat system has an advantage over a step and scan system in that it is not necessary to accelerate or decelerate the stage, thus improving

10 throughput.

Therefore, the size of the shot angle of view can serve as criteria in determining, for example, scanning exposure and static exposure. When switching is performed, a threshold etc. is provided for the

15 exposure apparatus so as to optimize throughput.

Furthermore, when an exposure is performed onto a wafer with a base, it is possible to conceive a method whereby the amount of false recognition by the base pattern of the focus sensor is measured before starting

20 the exposure, measurement reproducibility is measured to determine which of the static exposure focus and scanning exposure focus is to be used to optimize the accuracy and productivity of the exposure apparatus.

Furthermore, one of the features of the scanning

25 type exposure apparatus is an advantage of being able to set a magnification ratio for the scanning direction and non-scanning direction separately. For this reason,

when a magnification difference between directions after measuring the printing shape of the base shot is large, scanning exposure is selected and static exposure is selected otherwise to improve the focus accuracy and throughput. It is also possible for a control system selection determining section to determine switching between these exposure methods.

Furthermore, while the static exposure method may fail to obtain a focus point around a wafer, the scanning exposure method allows sensor measuring points to be moved, making it possible to perform exposure onto parts closer to the exposure area. Thus, it is possible to improve the focus accuracy by selecting an exposure method. Furthermore, it is also possible to simply classify types of exposure to be executed from now into categories such as maintenance and production and switch between the control systems based on this setting.

Moreover, in the case of scanning exposure, if the accuracy of wafer printing (CD, overlay, etc.) is reduced, it may be difficult to determine which of the accuracy of the lens or accuracy of stage performance has been reduced. Therefore, static exposure according to a step and repeat system is performed and the stage factor and lens factor of the wafer printing accuracy are separated.

Next, in the case of scanning exposure, it is also possible to switch between two types of cases, carrying out an exposure while running the stage at a constant speed and carrying out an exposure while accelerating or decelerating the stage. As the maximum scanning speed increases, it is necessary to increase stage acceleration and jerk in order to reduce the increase of the stage stroke.

Although it depends on the performance of the stage, there is concern that increasing the acceleration of the stage may deteriorate the accuracy of synchronization between stages. Thus, in a process whose required accuracy is high, it is effective to adopt a system of carrying out an exposure during acceleration or deceleration. Thinking in this way, it is possible to switch between two ways of exposure methods; exposure giving priority to throughput in the case of exposure at a constant speed and exposure focused on accuracy during acceleration or deceleration and it is desirable to select and determine from two types of alternatives, exposure at a constant speed or exposure during acceleration or deceleration.

Furthermore, it is also possible to switch between two scanning exposure methods according to the accuracy of synchronization required for the relevant process. At this time, it is also possible to select from among

the two exposure methods based on an abstract concept such as a recipe.

After determining switching between the static and scanning exposures systems, and switching between the two types of scanning exposure methods, the exposure method determining section determines the correction method, sequence, etc. required for the respective exposure methods.

For example, consider the two types of exposure methods; static exposure method and scanning exposure method. The static exposure method differs from the scanning exposure method in the positions of focus measuring points, exposure amount control system, magnification ratio correcting means and drive tables used when the stage is driven.

Furthermore, consider two types of exposure methods; exposure at a constant speed and exposure during acceleration or deceleration. The amount of false recognition of pattern at focus measuring points and tilt (amount of one-sided nebulosity) due to a difference in the amount of acceleration/deceleration and the method of adjusting illumination, etc. vary depending on the speed.

The exposure control system determining section has the functions of automatically determining the difference between static and scanning exposure methods or difference between scanning exposure at a constant

speed and exposure during acceleration or deceleration
and automatically invoking these correction items and
sequences separately. Furthermore, the differences
between exposure methods are conventionally handled

5   through operations of the exposure apparatus, but if an
exposure method can be set manually, that is enough.
Furthermore, it is also possible to store in a memory
the correspondence of various correction sequences
(measurement etc. required before carrying out exposure

10 processing) necessary for the respective exposure
methods and consider the respective processing times
and improvement of accuracy, or consider correction
values to be diverted from the exposure methods of the
previous wafer or lot, etc. and use these factors to

15 determine the exposure method.

Provided with such functions, it is possible to
constitute an exposure apparatus capable of
automatically switching between exposure methods
according to the purpose, accuracy and productivity.

20   Furthermore, the present invention is also
applicable to a semiconductor device manufacturing
method comprising a step of installing in a
semiconductor manufacturing factory a manufacturing
apparatus group for various processes including any one

25 of the above-described exposure apparatuses and a step
of manufacturing semiconductor devices through a
plurality of processes using the manufacturing

apparatus group. The semiconductor device

manufacturing method may further comprise a step of

connecting between apparatuses of the manufacturing

apparatus group via a local area network and a step of

5   communicating information on at least one apparatus in

the manufacturing apparatus group between the local

area network and an external network outside the

semiconductor manufacturing factory. It is also

possible to obtain maintenance information of the

10   manufacturing apparatus through data communication by

accessing a database provided by the vendor or user of

the exposure apparatus via the external network or

perform production control through data communication

with a semiconductor manufacturing factory other than

15   the above-described semiconductor manufacturing factory

via the external network. Especially, as a feature of

the exposure apparatus according to this system, it is

possible to acquire information on the lot or wafer

process distortion (magnification ratio, distortion) or

20   information on dust or wafer flatness from the

production control host via a network and use the

information for switching between exposure methods.

Furthermore, the present invention is also

applicable to a semiconductor manufacturing factory

25   comprising a manufacturing apparatus group for various

processes including any one of the above-described

exposure apparatuses, a local area network that

connects between apparatuses of the manufacturing

apparatus group and a gateway that enables access from

the local area network to an external network outside

the factory, making possible data communication of

5   information on at least one of apparatuses in the

manufacturing apparatus group.

Furthermore, the present invention is also

applicable to a maintenance method for any one of the

above-described exposure apparatuses comprising a step

10   of the vendor or user of the exposure apparatus

providing a maintenance database connected to the

external network of the semiconductor manufacturing

factory, a step of allowing access from the

semiconductor manufacturing factory to the maintenance

15   database via the external network and a step of sending

maintenance information stored in the maintenance

database to the semiconductor manufacturing factory via

the external network.

Furthermore, any one of the exposure apparatuses

20   of the present invention preferably further comprises a

display, a network interface and a computer to execute

network software to allow data communication of

maintenance information of the exposure apparatus via a

computer network, and the network software preferably

25   provides a user interface on the display to access the

maintenance database provided by the vendor or user of

the exposure apparatus connected to the external

- 26 -

network of the factory in which the exposure apparatus is installed, making it possible to acquire information from the database via the external network.

Based on the attached drawings, the exposure apparatuses of embodiments of the present invention will be explained below. FIG. 1 is a view illustrating an outlined configuration of an exposure apparatus of an embodiment of the present invention. In FIG. 1, reference numeral 1 denotes a light source and can be, for example, an excimer laser or i-ray lamp. Reference numeral 4 denotes a beam attenuating filter with a plurality of attenuation ratios to attenuate the light beam from the light source 1 and is an optical member represented by an ND filter with different transmittances. Reference numeral 2 denotes an optical unit for eliminating illumination irregularities by vibrating the angle of coherent light such as a laser beam; 3, a beam shaping optical system for shaping the light beam from the light source 1 and making it coherent; 5, an optical integrator; 6, a condensing lens for illuminating the surface of a masking blade 9 with the light flux from the optical integrator 5 which is a secondary light source.

Reference numeral 7 denotes a half-mirror, splits part of the light flux from the optical integrator 5 and the split light flux is introduced to a photo-detector 12 through a condensing lens 11 and used to

detect the amount of exposure when an exposure is performed onto a wafer 18 as a substrate. The masking blade 9 consists of four upper/lower and right/left independently operating light shielding plates and

5   exists on an optical conjugate plane with a reticule 16 as the original plate with respect to an image formation lens 10. An exposure slit 8 consists of two sets of light shielding plates whose shape shields the light flux in the direction perpendicular to the

10   optical axis on the plane of this sheet. Furthermore, since the exposure slit 8 is in a position shifted from the surface of the masking blade 9 in the optical axis direction, a light intensity distribution by the exposure slit 8 has a trapezoidal distribution as shown

15   in FIG. 2. FIG. 2 is a three-dimensional schematic view illustrating the light intensity distribution on the exposed surface.

    The image formation lens 10 introduces the light shielded by the masking to form an image on the

20   reticule 16. A projection lens 13 projects the image formed by the reticule 16 onto the wafer 18. The reticule 16 is positioned and placed on a reticule stage 15. The wafer 18 is placed on a wafer stage 17. These stages are driven in a floating state by means of

25   an air pat etc. and can be driven two-dimensionally freely.

The amount of exposure given to the surface of the wafer 18 is detected and controlled by the photo-detector 12. An illuminometer 14 is attached to the surface of the wafer 18 and a desired amount of

5   exposure is given to the surface of the wafer 18 by checking a relationship with the photo-detector 12 before starting an exposure.

An exposure apparatus interface (I/F) 21 specifies the operation of the exposure apparatus through its

10   input devices (keyboard 25 and mouse 26, etc.). At the same time, the exposure apparatus I/F 21 controls wafer printing conditions, printing layout, etc. allowing the operator to use the exposure apparatus by selecting conditions to be used from among the conditions under

15   control. Furthermore, the exposure apparatus I/F 21 may be connected to a trunk network in an environment in which the exposure apparatus is installed or to a local network 22, etc. and operating conditions, etc. of the exposure apparatus may be downloaded from there.

20   A main control section 19 executes various correction functions of the exposure apparatus, drives and controls the units according to the instructions of the operator given to the exposure apparatus I/F 21 or instructions downloaded from the trunk network 22.

25   One of the features of the exposure apparatus according to this embodiment is an exposure method determining section 20. The exposure method

determining section 20 selects an exposure method based on data such as the exposure conditions received by the main control section 19. The exposure method determining section 20 determines an evaluation item

5 value for every item necessary to determine an exposure method. This exposure method is determined according to a composite value of an evaluation item value for every shot, an evaluation item value for every wafer and an evaluation item value for every lot.

10 The evaluation content for every shot may include a shot size (angle of view), printing location on the surface of a wafer, situation of shot distortion, etc. The evaluation item value for every lot may include a layout shape in the preceding lot or layer, scan speed,

15 etc. About these evaluation items, evaluation item values in each shot of the lot loaded at that time are calculated. Those evaluation item values determine the exposure method.

The method of calculating evaluation item values

20 is as follows:

$$C(N): = F(SYL(N)) + G(SX(N), SY(N)) + H(\delta X(N), \delta Y(N)) + K(L) + P(M) + Q(S, SY(N)) \quad \dots \text{(Equation 1)}$$

In Equation 1, the names of the variables have the following meanings:

25 SYL: Size of the shot in the scanning direction

SX: Position of the shot on the wafer surface in the non-scanning direction

SY: Position of the shot on the wafer surface in

the scanning direction

δX: Image shift in the non-scanning direction in

the shot

5   δY: Image shift in the scanning direction in the

shot

L: Layout correlation coefficient

M: Lot printing method indication value

N: Shot number (index) on one wafer

10   S: Synchronization accuracy target value

C(N) in Equation 1 indicates the evaluation item

value of the (N-shot)th exposure method on the wafer,

provides a threshold for the value and determines which

system is used to perform an exposure for every shot;

15 scanning exposure (constant speed), scanning exposure

(accelerated/decelerated) or static exposure.

Basically, it is possible to determine the exposure

method using a one-dimensional index as shown in FIG. 3.

FIG. 3 shows that as the evaluation item value

20 calculated by Equation 1 increases in the + direction,

it is desirable to adopt scanning exposure as the

exposure method of the shot. On the contrary, it is

possible to determine that as the evaluation item value

calculated by Equation 1 increases in the - direction,

25 it is more advantageous to adopt a static exposure

method as the exposure method of the shot. As shown in

FIG. 3, an evaluation item value is calculated and a

threshold is provided for the value and finally the exposure method of the shot is determined based on the value.

The term of the function F in Equation 1 indicates an item related to the shot size. As the shot size reduces, acceleration/deceleration control of the stage increases with respect to the exposure scanning area (length), and therefore the static exposure method becomes more advantageous. Therefore, the evaluation item value according to the shot size is, for example, as shown below:

$F(SYL): = FA \times SYL + FB$ (where $SYL \leq SLW$: exposure light width) ... (Equation 2)

where, FA and FB are constants and predetermined values. (Equation 2) is effective when SYL is smaller than exposure light width SLW. There may also be cases where the value of (Equation 2) will increase exponentially.

The term of the function G in Equation 1 is a term related to the location of a shot and gives an evaluation of the exposure method. There may be cases where it is necessary to change the shot location according to the feature of the focus detection method of the exposure apparatus or change the focus method according to the feature corresponding to the location. Thus, the term G reflects influences of these cases. Alternatively, this term of the function G reflects the

- 32 -

case where the situation of shot distortion of the base layer has location dependency.

In the focusing according to the scanning exposure method, it is a general practice that the focus at each position is measured during a scan and the focusing is performed according to this value. For this reason, it is necessary to perform focus measurement in real time while the wafer is moving, which generally results in low performance of tracking irregularities on the wafer surface (dust, fouling on the chuck, etc.). On the other hand, since it is possible to perform focus measurement at any position during a scan, satisfactory focus measurement is attained even in areas such as the perimeter of a wafer where focus measurement is applicable to only a limited area. Therefore, more specifically, the G term reflects influences in the following case.

FIG. 4 will be explained. FIG. 4 shows that exposure shot layouts (rectangular areas in FIG. 4) are formed on the surface of the wafer 18 (circle in FIG. 4) and exposure is performed according to these layouts. Reference numeral 402 shows the position at which a focus sensor performs measurement (focus measuring position). A shot 401 is a shot where static exposure is performed around the perimeter of the wafer 18, while a shot 403 is a shot where scanning exposure is performed around the perimeter of the wafer 18.

Static exposure performs exposure to shots all together and if some measuring points are outside the wafer as in the case of the shot 401, the remaining four measured values are used to perform exposure to

5 the entire shot. In contrast, in the case of the shot 403, exposure is performed simultaneously with a scan and move, and therefore only the focus measuring point at the shot edge receives influences of being outside the wafer. Therefore, the scanning exposure method

10 guarantees the focus accuracy as far as the measuring points are included in the shot 403 without going beyond the perimeter of the wafer. That is, the G term reflects influences of focus measuring points according to such shot locations.

15 Furthermore, reference numeral 404 denotes dust stuck to the surface of the wafer 18. In the case of shots 405 and 406 to which dust is stuck, it is seen that the shot 405 is subjected to static exposure while the shot 406 is subjected to scanning exposure. Since

20 fewer focus measuring points are located in the shot 405, the probability of measuring dust is low, preventing the entire shot 405 from being defocused unnecessarily. In contrast, the shot 406 is under scanning exposure and there are more focus measuring

25 points in the shot than during static exposure. Thus, there is a higher probability in the case of the shot 406 that dust will also be measured and more areas will

be defocused than the shot 405. Similarly, information on irregularities on the surface of the chuck on which a wafer is placed is stored in memory etc. and these irregularities may be treated in the same way as in the

5 case of dust. In addition, it is also possible to acquire information on wafer irregularities to be processed from a network and reflect the information in the G term. That is, the G term reflects influences of information on wafer irregularities due to dust or

10 chuck irregularities.

The H term in Equation 1 is a term related to a shape shift of the base pattern of the relevant shot when multiple printing is performed. A significant difference between the scanning exposure method and

15 static exposure method in the alignment performance is that the scanning exposure method allows a magnification ratio of a shot (primary, tertiary component, etc.) to be corrected in the scanning direction and non-scanning direction. Thus, it is

20 possible to switch between exposure methods according to positional differences between the scanning and non-scanning directions. For example, the following evaluation expression is conceivable:

$$H(\delta X(N), \delta Y(N)) := HA \times |\delta X(N) - \delta Y(N)| + HB$$

25
... (Equation 3)

where, HA and HB are constants and predetermined.

The term of the K function in Equation 1 is a term generated when the previously measured correction data is diverted. When the same base or process exists in the exposure apparatus or on-line host, etc., the

5   correction data of the lot may be diverted, which makes it possible to improve throughput. For example, the area subject to focus measurement varies in a shot between two exposure methods; the scanning exposure method and static exposure method.

10   The focus measuring points 402 in reference numerals 403 and 406 in FIG. 4 show focus measuring points according to the scanning exposure method, while the focus measuring points 402' in reference numerals 401 and 405 show focus measuring points according to

15   the static exposure method. Since the amount of false recognition is included in the amount of measurement under the influence of the base layer during focus measurement, the base pattern is measured before exposure, the amount of false recognition is measured

20   and the amount of focus measurement is corrected. The base pattern varies depending on the location, but when both the base pattern and the relevant wafer shot layout are the same, focus measurement may be omitted. Moreover, measuring conditions etc. during measurement

25   when alignment is performed can also be basically diverted as long as both the base pattern and layout are the same. However, wafer factors and resist

application conditions may vary depending on the lot,

and therefore the substitution of a focus measured

value of the previous lot becomes a trade-off between

throughput and accuracy. Thus, for example, the term

of the function K is expressed by the following

expression:

$$K(L): = KA \times L \qquad\qquad ... \text{(Equation 4)}$$

where, KA is a constant and a predetermined value.

"L" here refers to a shot layout correlation

coefficient and L is a coefficient which becomes 0 when

the shot coordinates of a layout are shifted or the

base pattern or layout is wrong, and becomes 1 when all

items are identical.

The term of the function P in Equation 1 indicates

the method of printing the lot and when the lot is to

be printed by limiting it to either of the exposure

methods, the indication of the printing method is

reflected in evaluation item values through this item.

Inclusion in the evaluation item values prevents the

user from specifying the printing method erroneously.

$$P(M): = PA|M: = \text{specification of static exposure method}$$

$$PB|M: = \text{specification of scanning exposure method}$$

$$... \text{(Equation 5)}$$

Here, PA and PB are constants and predetermined

values.

- 37 -

If, for example, SLW in Equation 2 is greater than a default value, impossibility of exposure by either exposure method may be determined by an exposure layout or recipe. For example, when shot width in the
5   scanning direction SYL is greater than exposure light with SLW, batch exposure is not possible in the static exposure method, and therefore either one of the two exposure methods is used. In this case, various methods may be used such as preventing the evaluation
10 item value from falling below a threshold 1 by adding the threshold 1 to the evaluation item value as shown in FIG. 5A, or totally applying scanning exposure (at a constant speed) when an evaluation item value smaller than the threshold 1 is calculated as shown in FIG. 5B.
15 Moreover, instead of providing the P term, the threshold may also be changed.

When stage synchronization accuracy is specified, the Q term in Equation 1 is the term corresponding thereto. The synchronization accuracy of each drive
20 stage of a scanning type exposure apparatus generally deteriorates as the acceleration of the stage increases. That is, static exposure or scanning type exposure method (accelerated/decelerated) is advantageous under the setting with strict synchronization accuracy,
25 whereas it has demerits such as limitation of the exposure area and reduction of throughput, etc.

Therefore, the term Q of synchronization accuracy may be set as follows:

Q(S, SY(N)): KA

where, SY(N)≤SLW, S≤SR   : KB

where, SY(N)>SLW, S≤SR   : KC for other than

above

... (Equation 6)

In Equation 6 above, S denotes a synchronization accuracy target value, SR denotes a synchronization accuracy required value, and when S is smaller than this value, the requirement for synchronization accuracy is high and it is necessary to apply exposure according to the static exposure method (KA is added to the evaluation item value) or accelerated/decelerated scanning exposure method (KB is added to the evaluation item value). In other cases, evaluation item values are basically calculated without considering this item.

Then, processing of the exposure apparatus according to this embodiment will be shown in FIG. 6. Once a lot process is started, exposure method determining step S101 is executed by an exposure condition determining section 20 where any one of static, scanning (at a constant speed) or scanning (accelerated/decelerated) exposure methods is determined. In determining the exposure method, the determining mode process, determining condition data, etc. in steps S103 to S105 are referenced. The

exposure method determining mode (S103) is a processing step of determining whether the exposure method is determined automatically (by the exposure apparatus) or manually (according to user specification). The user himself/herself determines this and can input this processing step to the exposure apparatus I/F 21 using the keyboard 25 etc. beforehand. Furthermore, the setting of the determining condition data (S104) is a step of setting data concerning various kinds of required accuracy such as alignment accuracy of the lot to be processed, focus accuracy, exposure accuracy and the determination of the exposure method including wafer shape data such as the lot layout and base pattern condition. Exposure method (S105) is a step of setting data by exposure method used when the determination result in the determining mode S103 is manual and three values of static, scanning (at a constant speed) and scanning (accelerated/decelerated) are set. This is a step of determining an optimal exposure method for the lot to be processed using these two data groups. After the exposure method is determined, lot processing step S102 processes the lot according to the determined exposure method and terminates the lot processing.

Next, a detailed flow of exposures system determining step S101 will be shown in FIG. 7. Once the exposures system determining processing starts, the

process moves on to determining mode determining step S201 first. Here, if the mode is set in such a way that the user forcibly specifies the exposure method and exposure is performed according to that system, the

5   exposures system determining process is terminated without calculating evaluation item values. If an automatic determining (the exposure apparatus-determined) mode is selected in determining mode determining step S201, the process of each evaluation

10   item calculating step S202 is performed. Here, values corresponding to above-described Equations 1 to 6 are calculated. If a few exposure methods cannot be executed due to exposure conditions etc. at this time, evaluation item value offset data is registered (S204).

15   More specifically, as described above, if batch exposure is not possible according to a static exposure method, for example, when shot width in the scanning direction SYL is greater than exposure light width SLW according to an exposure layout or recipe, such a value

20   that will make the evaluation item value exceed a scanning exposure threshold in all cases by adding a value exceeding threshold data to the evaluation item value obtained through a calculation is registered as an offset value, or contrarily a value that will reduce

25   this threshold is registered as an offset value. Then, the evaluation item value is determined using Equation 1 (S203) and it is determined which of the exposure

methods the evaluation item value matches. The value
of the evaluation item value offset data registered at
this time (S204) is acted on the evaluation item value
or threshold to make a correct evaluation and

5   determination. Alternatively, as described above, when
batch exposure according to the static exposure method
is not possible, it is also possible to forcibly
perform exposure according to the scanning exposure (at
a constant speed) system. In this case, an instruction

10   for performing exposure according to the scanning
exposure (at a constant speed) system itself acts as an
offset.

On the contrary, when synchronous scanning,
scanning exposure control or scanning focus measurement,

15   etc. cannot be performed because exposure apparatus
adjustment etc. is not ready, if an automatic
determining mode is selected, it is also possible to
register as an offset value a value that will make the
evaluation item value fall below a scanning exposure

20   threshold in all cases by subtracting it from the
evaluation item value, or contrarily register as an
offset value a value that will increase this threshold
and determine the evaluation item value using Equation
1 or forcibly perform exposure according to the static

25   exposure method.

There are cases where an exposure angle of view of
a wafer to be processed may vary from one shot to

another. For example, a TEG (Test Element Group: pattern for a chip test) etc. is placed between exposure shots and processed in the same process. In this case, the exposure angle of view varies a great deal from one shot to another, and therefore determining an exposure method for every shot can provide more accurate exposure for each shot without averaging evaluation item values and also improve throughput of the wafer. Thus, the present invention can also determine an exposure method for every shot or wafer. As the processing content in such a case, it is possible to group shots taking into account exposure conditions (angle of view, synchronization accuracy, etc.) for each shot beforehand, by determining exposure methods for all shots of the wafer and performing processing according to the exposure method common to most shots, etc., and calculate the value in Equation 1 for each group.

This system can also be used for when the exposure apparatus is used for purposes other than a normal purpose such as maintenance. Two specific processing flows as the exposure method determining pre-processing will be shown in FIG. 8A and FIG. 8B. The flow chart shown in FIG. 8A is a method of directly changing a determining mode. The purpose when the exposure apparatus is driven is determined in step S301 and a purpose-specific optimal exposure method is referenced

in step S302. Determination according to a purpose-
specific optimal exposure method is a process of
registering an optimal exposure method according to the
purpose beforehand and determining an optimal system

5   from among the registered systems and an optimal
exposure method is determined when a purpose is given.
In step S303, the optimal exposure method obtained is
registered in exposure method-specific data (S105) and
the determining mode (S103) is specified as "manual" by

10   specification of the exposure method determining mode
in step S304. Furthermore, the flow shown in FIG. 8B
applies to the system whereby evaluation item values
are shifted. The process up to step S302 is the same
process as that of the flow shown in FIG. 8A and by

15   evaluation item value offset registration in step S305,
an evaluation item value offset is registered (S204).
By determining mode specification in step S306, a
determining mode is automatically specified (S103).
Either of these two exposure method determining pre-

20   processes allows an exposure method that matches the
processing purpose to be determined.

The user I/F of the exposure apparatus according
to this embodiment may include input items such as
specifications of exposure purpose, exposure method and

25   determining mode, etc. and output items such as an
exposure method according to which lots are currently
being processed. Both or either of these input and

output items may be displayed at the exposure apparatus to assist the operator in operations. Even if the input item is hidden in the lot processing recipe, the exposure apparatus according to the present invention

5   can be still constituted. Furthermore, the output item may also be referenced on line etc.

Providing the above-described contents, the exposure apparatus according to this embodiment has the effects of being able to select an optimal exposure

10   method, operate an optimal apparatus according to the purpose and optimize throughput easily.

(Embodiment of semiconductor production system)

Then, an example of a semiconductor device (semiconductor chips such as IC and LSI, LCD panel, CCD,

15   thin-film magnetic head, micromachines, etc.) production system using the exposure apparatus according to the present invention will be explained. This is a system that performs maintenance services such as handling of trouble of the manufacturing

20   apparatus installed in a semiconductor manufacturing factory, periodic maintenance and supply of software, etc. using a computer network outside the manufacturing factory.

FIG. 9 is a view of the overall system extracted

25   from a certain angle. In FIG. 9, reference numeral 1101 denotes the office of the vendor (apparatus supplier) who supplies a semiconductor device

manufacturing apparatus. Actual examples of the
manufacturing apparatus include a semiconductor
manufacturing apparatus for various processes used in a
semiconductor manufacturing factory, for example, pre-
5   processing equipment (lithography apparatus such as
exposure apparatus, resist processor, etching apparatus,
and thermal processor, film formation apparatus,
flattening apparatus, etc.) and post-processing
equipment (assembly apparatus, inspection apparatus,
10   etc.). The office 1101 is equipped with a host control
system 1108 that supplies a maintenance database for
the manufacturing apparatus, a plurality of operation
terminal computers 1110 and a local area network (LAN)
1109 constructed by connecting these computers to
15   construct an intranet etc. The host control system
1108 is equipped with a gateway to connect the LAN 1109
to the Internet 1105 which is a network outside the
office and a security function to restrict accesses
from the outside.

20   On the other hand, reference numerals 1102 to 1104
denote manufacturing factories of semiconductor
manufacturers who are the users of the manufacturing
apparatuses. Manufacturing factories 1102 to 1104 may
be factories belonging to manufacturers different from
25   each other or may be factories belonging to the same
manufacturer (for example, a pre-processing factory and
post-processing factory, etc.). The factories 1102 to

1104 are each equipped with a plurality of
manufacturing apparatuses 1106, a local area network
(LAN) 1111 that connects these apparatuses to construct
an intranet etc. and a host control system 1107 as a
5   monitoring apparatus for monitoring the operating
situation of each manufacturing apparatus 1106. The
host control system 1107 provided for each factory 1102
to 1104 is equipped with a gateway to connect the LAN
1111 in each factory to the Internet 1105 which is a
10   network outside the factory. This allows the users
from the LAN 1111 in each factory to access the host
control system 1108 on the vendor 1101 side via the
Internet 1105 and allows only the users restricted by
the security function of the host control system 1108
15   to access. More specifically, it is possible to notify
status information indicating the operating situation
of each manufacturing apparatus 1106 (for example,
situation of a manufacturing apparatus in which trouble
occurs) from the factory to the vendor via the Internet
20   1105 or receive information of a response to the
notification (for example, information indicating a
troubleshooting method, troubleshooting software or
data), maintenance information such as latest software
and help information, etc. from the vendor. For data
25   communications between each factory 1102 to 1104 and
the vendor 1101 and for data communications between
LANs 1111 of the respective factories, a communication

protocol (TCP/IP) generally used over the Internet is used. Instead of using the Internet as the external network outside the factories, it is also possible to use a dedicated network (ISDN etc.) with high security

5   preventing a third party's access. Furthermore, the host control system is not limited to the one supplied by the vendor, but the user can also construct a database, place it on an external network and allow a plurality of the user's factories to access the

10   relevant database. Here, data such as the aforementioned evaluation item value or determining mode used to deduce it, determination conditions, exposure method is sent to the vendor as the status information indicating the operating situation of the

15   exposure apparatus, and the host control system 1108 on the vendor side or any of the operation terminal computers 1110 connected thereto processes this statistically and sends software or help information that matches the operating situation of each exposure

20   apparatus to the host control system 1107 on the factory side. On the other hand, the exposure apparatus side can also receive values such as process distortion (magnification ratio, distortion) etc. of lots and wafers currently being processed, dust,

25   irregularities on the wafer surface, etc. from the vendor side or the control system on the user side and

use this information for switching between exposure methods.

Here, FIG. 10 is a conceptual diagram of the overall system of this embodiment extracted from an angle different from that in FIG. 9. The foregoing example describes the case where a plurality of user factories each equipped with a manufacturing apparatus and the control system of the vendor of the manufacturing apparatus are connected via an external network and production control of each factory and data communication of information of at least one manufacturing apparatus are carried out via the external network. In contrast, this example describes a case where a factory equipped with manufacturing apparatuses of a plurality of vendors, the plurality of manufacturing apparatuses and the control systems of the respective vendors are connected via an external network outside the factory and maintenance information of each manufacturing apparatus is communicated with each other. In FIG. 10, reference numeral 1201 denotes a manufacturing factory of the manufacturing apparatus user (semiconductor device manufacturer) and the manufacturing line of the factory introduces manufacturing apparatuses for carrying out various processes, here for example, an exposure apparatus 1202, a resist processor 1203 and a film formation processor 1204. FIG. 10 describes only one manufacturing factory

1201, but a plurality of factories are actually
connected via a network in a similar way. The
respective apparatuses in the factory are connected via
a LAN 1206 to form an intranet and the host control
5 system 1205 controls movements of the manufacturing
line.

On the other hand, offices of vendors (apparatus
suppliers) such as an exposure apparatus manufacturer
1210, a resist processor manufacturer 1220 and a film
10 formation apparatus manufacturer 1230 are each equipped
with host control systems 1211, 1221 and 1231 for
carrying out remote maintenance of the supplied
apparatuses and these systems are each equipped with a
maintenance database and a gateway which is an external
15 network as described above. The host control system
1205 that controls the apparatuses in the user
manufacturing factory and the vendor control systems
1211, 1221 and 1231 for the respective apparatuses are
connected via the Internet which is an external network
20 1200 or a dedicated network. If trouble occurs in any
one of the apparatuses on this manufacturing line in
this system, the manufacturing line ceases to operate,
but by receiving remote maintenance from the vendor of
the apparatus in trouble via the Internet 1200, it is
25 possible to speedily cope with the trouble and suppress
the interruption of the manufacturing line to a minimum.

The manufacturing apparatuses installed in the
semiconductor manufacturing factory are each equipped
with a display, a network interface, and a computer
that executes network access software stored in a
5   storage device and software for operation of the
apparatus. As the storage device, a built-in memory,
hard disk or network file server, etc. is available.
The above-described network access software includes a
dedicated or general-purpose web browser and provides
10   on a display a user interface with a screen whose
example is shown in FIG. 11. The operator who controls
the manufacturing apparatus in each factory enters,
while referencing the screen information such as the
model 1401 of the manufacturing apparatus, serial
15   number 1402, case name of trouble 1403, date of
occurrence 1404, emergency level 1405, symptom 1406,
remedy 1407, progress 1408, etc. in input items on the
screen. The information entered is sent to a
maintenance database via the Internet and the resulting
20   appropriate maintenance information is replied from the
maintenance database and shown on the display.
Furthermore, the user interface provided by the web
browser further provides hyper link functions 1410 to
1412 as shown in the figure, allowing the operator to
25   access further detailed information of each item,
extract software of the latest version to be used for
the manufacturing apparatus from a software library

provided by the vendor or extract an operation guide
(help information) to be used as reference for the
factory operator. Here, the maintenance information
provided from the maintenance database also includes

5   information on the above-described present invention
and the above-described software library also provides
the latest software to implement the present invention.
That is, as one piece of status information indicating
the operating situation of the corresponding exposure

10 apparatus, data such as the aforementioned evaluation
item values or determining mode used to deduce the
evaluation item values, determining condition and
exposure method is sent to the corresponding vendor of
the exposure apparatus, and the host control system on

15 the vendor side or any operation terminal computer
connected thereto processes this data statistically and
sends software or help information that matches the
operating situation of each exposure apparatus to the
host control system 1205 on the factory side. The host

20 control system 1205 transfers the relevant information
only to the corresponding exposure apparatus.

Then, the manufacturing process of the
semiconductor devices using the above-described
production system will be explained. FIG. 12 shows a

25 flow of an overall manufacturing process of
semiconductor devices. In step S1 (circuit design), a
circuit design for a semiconductor device is carried

out. In step S2 (mask fabrication), a mask on which
the designed circuit pattern is formed is fabricated.
On the other hand, in step S3 (wafer manufacturing), a
wafer is manufactured using a material such as silicon.

5   Step S4 (wafer process) is called a "pre-process" in
which an actual circuit is formed on the wafer using
the mask and wafer prepared above using a lithography
technology. The next step S5 (assembly) is called a
"post-process" and is a step in which a semiconductor

10 chip is created using the wafer manufactured in step S4
and includes assembly processes such as an assembly
process (dicing, bonding), packaging process (chip
sealing), etc. In step S6 (inspection), the
semiconductor device manufactured in step S5 is

15 subjected to an operation check test and resistance
test, etc. The semiconductor device is completed
through these processes and shipped (step S7). The
pre-process and post-process are carried out at
different dedicated factories and maintenance is

20 performed using the above-described remote-controlled
maintenance systems at the respective factories.
Between the pre-process factory and post-process
factory, information for production control and
maintenance of the apparatuses is communicated with

25 each other via the Internet or a dedicated network.

FIG. 13 shows a detailed flow of the above-
described wafer process. In step S11 (oxidation), the

- 53 -

surface of a wafer is oxidized. In step S12 (CVD), an
insulation film is formed on the surface of the wafer.
In step S13 (formation of electrodes), electrodes are
formed on the wafer by means of vapor deposition. In
step S14 (ion implantation), ions are implanted into
the wafer. In step S15 (resist processing), a
photosensitive material is applied to the wafer. In
step S16 (exposure), the above-described exposure
apparatus prints the mask circuit pattern onto the
wafer and performs exposure. In step S17 (development),
the exposed wafer is developed. In step S18 (etching),
the part other than the developed resist image is
chipped off. In step S19 (resist stripping), the
unnecessary resist after the etching is removed. By
repeating these steps, multiple circuit patterns are
formed on the wafer. The manufacturing apparatus used
for each process is subjected to maintenance using the
above-described remote-controlled maintenance system,
which prevents trouble or even if trouble occurs it is
possible to speedily recover the original condition,
thus improving productivity of semiconductor devices
compared to the conventional systems.

As many apparently widely different embodiments of
the present invention can be made without departing
from the spirit and scope thereof, it is to be
understood that the invention is not limited to the

specific embodiments thereof except as defined in the
claims.